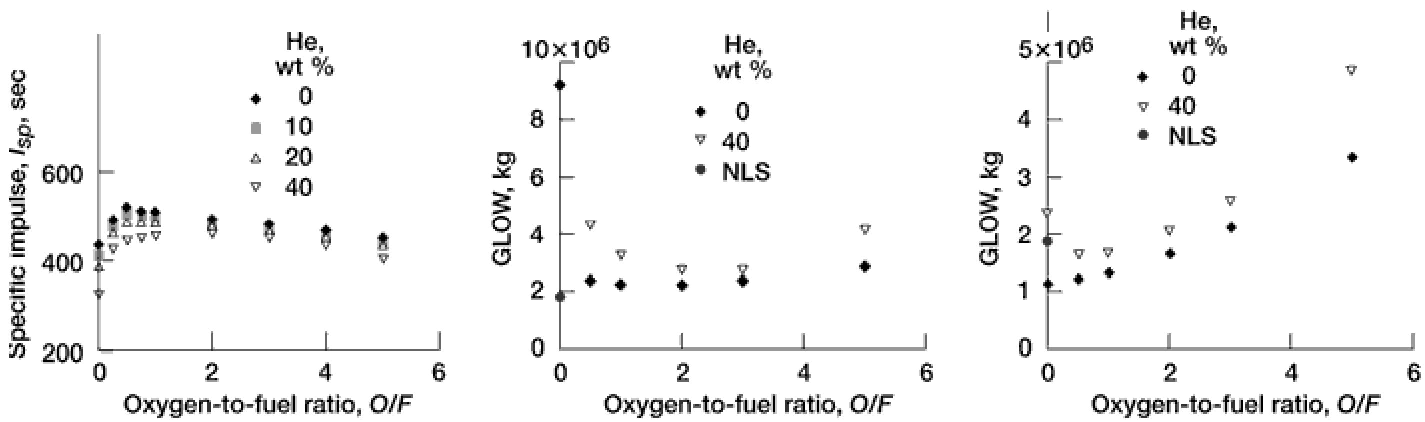
Atomic Rocket Vehicle Performance Improved

The NASA Glenn Research Center at Lewis Field conducted several analyses of atomic rocket propulsion systems (refs. 1 and 2). The atomic rocket engine performance and gross lift-off weight (GLOW) of several vehicle designs were used to describe the best atom loadings in rocket fuels. These best loadings will influence the vehicle dry mass, GLOW, and rocket pressurization system. Both monopropellant (fuel only with no oxidizer) and bipropellant (oxidizer and fuel) propulsion systems were assessed. The left graph provides the rocket's specific impulse I_{sp} for a type of atomic boron rocket: 22-wt % atomic boron. These I_{sp} values were computed with several helium loadings. The helium, added to the fuel mass, creates a gelled liquid to carry the atomic fuel to the rocket engine from its fuel tank. As the helium is added, the I_{sp} values are reduced, but not so much that the rocket vehicle becomes impractical.



Left: Atomic boron engine specific impulse; 22-wt % B. Center: Atomic boron GLOW; 22-wt % B. Right: Atomic boron GLOW; 50-wt % B.

The center graph illustrates the GLOW of rocket vehicles using the 22-wt % atomic boron propellants. The baseline rocket and payload weight for the comparison is an oxygen/hydrogen National Launch System (NLS) rocket taking 96,000 kg of payload to Earth orbit; the complete rocket and payload weighs 1,891,000 kg. For the atomic rockets, the helium addition has a strong influence on the GLOW. At an oxygen-to-fuel ratio O/F of 0.0, the rocket vehicle is too massive to be practical. At an O/F of 2.0, the mass of the 22-wt % atomic boron rocket GLOW decreased to a level comparable to the baseline oxygen/hydrogen NLS rocket GLOW. The right graph shows the GLOW for the 50-wt % atomic boron ($O/F = 0.0$). It is very low in comparison to the baseline GLOW; atomic boron allows a 39-percent GLOW reduction. With 40-wt % He added, instead of having a mass that is about 61 percent of the NLS baseline vehicle GLOW, the rocket's GLOW is much greater than the baseline. However, at an O/F ratio of 0.5 or 1.0, even with the addition of helium, the GLOW is still significantly lower than the baseline of 1,891,500 kg. The operating points for atomic rockets must be carefully selected; and these techniques illustrate the way to assess the best operating points.

References

1. Palaszewski, B.: Launch Vehicle Performance for Bipropellant Propulsion Using Atomic Propellants With Oxygen. AIAA Paper 99–2837, 1999.

2. Palaszewski, B.: Atomic Propellants for Aerospace Propulsion Systems: Solid Hydrogen Experiments and Vehicle Analyses. Presented at the 1999 USAF High Energy Density Materials Contractors Conference, Cocoa Beach, FL, June 8-10, 1999.

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